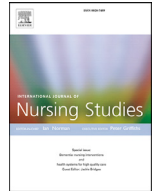




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How the public used face masks in China during the coronavirus disease pandemic: A survey study

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ARTICLE INFO

Article history:

Received 20 August 2020

Received in revised form 18 November 2020

Accepted 21 November 2020

Keywords:

Behaviour

Public compliance

Coronavirus disease

COVID-19

Masks

ABSTRACT

Background: Universal face mask use was recommended owing to the growing pandemic of the coronavirus disease (COVID-19). However, little is known about the public's compliance with mask-wearing behaviours.

Objective: To evaluate the public's mask-wearing behaviours in the context of COVID-19.

Design: Cross-sectional study.

Setting: Online survey from 6 April 2020 to 5 May 2020 in China.

Participants: This study included 10,165 persons who lived in China, understood Chinese, and were not health care providers.

Methods: Descriptive statistics were used to assess the public's mask-wearing behaviours. A binary logistic regression analysis was performed to identify the risk factors affecting the mask-wearing behaviours.

Results: Nearly all (99%) people wore a mask during the covid-19 pandemic, with most (73.3%) demonstrating good compliance with face mask use. However, 41.8% of the participants seldom cleaned their hands before putting on a face mask, and more than half (55.3%, 62.1%) of those who touched (n=8108, 79.8%) or adjusted (n=9356, 92.0%) their mask while using it failed to consistently wash their hands afterward. When removing a used mask, 7.6% of the participants discarded it into a garbage bin without a lid and 22.5% discarded it into a garbage bin in their reach regardless of presence of a lid. Participants reported wearing disposable medical masks (93.8%), followed by N95 respirators (26.2%), and cloth face masks (8.5%). Some participants wore multiple masks simultaneously (occasionally 26.5%, often 2.1%, always 1.5%). A total of 5,981 (58.8%) participants reported reusing disposable masks, with nearly two thirds (n=3923, 65.6%) indicating they would hang the used masks in well-ventilated places. More than one-third (37.6%) of the respondents did not replace mask when it had been used for more than 8 hours. Exposure to instructions on face mask use was the strongest predictor of good compliance (odds ratio=4.13, 95% confidential interval= 3.60-4.75, $p=0.000$). Other factors included specific situations, location, and gender. The influence of age needs further investigation. Most participants (76.4%) accessed information mainly via social media platforms.

Conclusions: Nearly all people wore face mask and most of them used it properly during the COVID-19 pandemic. Hand hygiene before and during mask-wearing, choosing an appropriate type of face mask, reusing disposal face mask, and disposing of used face masks should be particularly emphasized in future evidence dissemination or behaviour-change interventions. Information on social media platforms for evidence dissemination and behaviour change may benefit the public the most, but this initiative requires further research to investigate its effectiveness.

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What is already known about the topic?

- Precautionary mass masking may help control the spread of the COVID-19 pandemic.
- The public were unlikely to wear masks properly or consistently, which is essential for increasing effectiveness of mask wearing.

What this paper adds

- Most people chose and used the face masks properly in the context of COVID-19.
- Hand hygiene before and during mask-wearing should be particularly emphasized in future evidence dissemination or behaviour-change interventions, while choosing the appropriate type of face mask, reusing disposal face mask, and disposing of used face masks also cannot be neglected.
- Exposure to instructions regarding face mask use was the strongest predictor of good compliance with mask-wearing behaviours, irrespective of the participants' educational background.

1. Background

Through 19 Aug 2020, more than 21 million coronavirus disease (COVID-19) patients have been confirmed in 215 countries and regions, with 775,893 deaths (WHO, 2020a). The health authorities in many countries, including China, the United States, South Korea, Canada, Israel, and Austria, have mandated or recommended the wearing of face masks in public settings (National Health Commission of the People's Republic of China, 2020; Center for Disease Control and Prevention CDC, 2020; Lee 2020; Government of Canada, 2020; Mahase, 2020). In addition, many comments or evidences have advocated precautionary mass masking, given the progress of the pandemic and the new evidence of transmission by asymptomatic or pre-symptomatic persons (Greenhalgh et al., 2020; Desai et al., 2020; Cheng et al., 2020; Terry 2020; Leung et al., 2020; Pleil et al., 2020; Han et al., 2020; MacIntyre et al., 2020). Although there are concerns regarding the lack of randomised controlled trial evidence of the benefit of universal mask use (WHO, 2020b; Marin, 2020; Greenhalgh, 2020; Cheng et al., 2020), the absence of evidence is not evidence of absence, so an ethical principle, that is, a parachute approach to evidence (Potts et al., 2006) should be adopted in such a serious situation.

In China, the recommendation to wear face masks at the start of the beginning of the COVID-19 epidemic (National Health Commission of the People's Republic of China, Jan. 31, 2020). From mid-to-late March, increasingly more provinces of China declared no more confirmed cases of COVID-19 and gradual return to work was permitted. However, the second wave of COVID-19 in China was of concern due to imported cases. The public use of face masks might be one of the most effective strategies to reduce the transmission of COVID-19 and was recommended by the National Health Commission of China in its guideline issued on 18th of March (National Health Commission of the People's Republic of China, March 18, 2020). Subsequently, face masks have continued to be commonly used by the public in China since the return to work.

When recommending that the general population wear masks, however, health authorities and experts warned that improper face mask use could increase the risk of infection (Mahase, 2020; WHO, 2020b; Feng et al., 2020). Although the virus may survive on the surface of the face masks (Osterholm et al., 2015), the public may not change masks often, wash hand frequently, and properly remove and dispose of used masks (Mahase, 2020). Moreover, cloth

masks, disposable medical masks, and N95 respirators are recommended based on different situations (National Health Commission of the People's Republic of China, 2020), but the public may not have access to the relevant information, which may lead to irrational selection of face masks and contribute to wastefulness of resources. Thus, this study used social media to conduct an online survey on the public's mask-wearing behaviours in the context of the COVID-19 pandemic and provide the guidelines for participants with strategies to preserve the achievements in mitigating and controlling the covid-19 epidemic.

2. Methods

2.1. Research design

An online cross-sectional survey was conducted from 6 April 2020 to 5 May 2020. WeChat was used for questionnaire dissemination because it is the most popular social media, with 1.15 billion active users in China (Tencent, 2020). People who lived in China and understood Chinese were eligible for the study, while those who were health care providers were excluded. As we did not have any hypothesis, the sample size was not estimated. A convenience sampling was adopted to obtain as many respondents as possible.

2.2. Instrument

The questionnaire was developed based on the guidelines issued by the National Health Commission of China (National Health Commission of the People's Republic of China, Feb.5, 2020; March 18, 2020), World Health Organization (WHO, 2020b), and others (Feng et al., 2020). Five participants with varied education levels (i.e., middle school to PhD) and employment (i.e., shop assistant, financial manager, nurse, university faculty, and retired) were invited to comment on the questionnaire. The questionnaire was modified based on their comments. Afterward, we recruited 10 participants in a pilot study using convenience sampling to evaluate the feasibility of the questionnaire, duration to completion, and to obtain further comments on the tool's utility. A 5-point Likert scale (from totally disagree to fully agree) was used to assess whether the questions were easy to answer and clearly stated, and whether the questionnaire was well laid out. (Details are shown in Table 1)

The final version of the questionnaire was titled "Questionnaire on Face Masks Use for the Public (Except Healthcare Workers)" and consisted of two parts: (1) socio-demographic characteristics, with 12 items, including gender, age, city/province, education level, work/living environment, any symptoms of coughing or sneezing in the past week, living with a COVID-19-confirmed individual(s) in the past week, when and what type of face masks were selected, whether they had been exposed to education on the use of face masks, and how they had acquired this knowledge; and (2) mask-wearing behaviours, with 16 items, including mask-wearing habits, methods for mask disposal, frequency of mask changing, and mask reuse (Supplementary Materials). A 4-point Likert scale (never, occasionally, often, every time), as well as forced-choice, and multiple-choice answers were used in the questions of the second part and were calculated for a total score ranging from 12 to 60. The respondents were provided instant feedback rated as "Requires significant improvement" (<36 points), "Good but needs improvement" (36–41 points), "Very good" (42–50 points), or "Excellent" (51–60 points). Before beginning, the participants received a brief introduction to the survey. After each participant completed the survey, instant feedback was provided using a self-made mind map and the WHO video, which showed the correct way of choosing, wearing, and disposing of face masks (WHO, 2020b).

Table 1

Demographic characteristics of the pilot study participants and their comments.

| No. | Gender | Age | Job | Education Level | Reported time to complete the survey (minute) | Whether the questions were easy to answer | Whether the questions were clearly stated | Whether the questionnaire was well laid out | Other comments |
|-----|--------|-----|------------------|-----------------|---|---|---|---|--|
| 1 | Female | 51 | Nanny | Primary school | 5 | 4 | 4 | 5 | The access code are more clear at the bottom of the poster |
| 2 | Female | 13 | Student | Middle school | 2 | 5 | 4 | 5 | No special comments |
| 3 | Male | 38 | Civil servant | College | 3 | 5 | 5 | 4 | The mask pictures should be more close to the answers |
| 4 | Female | 44 | Full-time mother | College | 3 | 4 | 5 | 5 | provide the rate of instant feedback scores so that the participants more clearly know how well they behaved |
| 5 | Female | 40 | Teacher | PhD | 4 | 5 | 5 | 5 | No special comments |
| 6 | Female | 30 | Teacher | Master | 3 | 5 | 4 | 5 | No special comments |
| 7 | Female | 25 | Student | postgraduate | 2 | 4 | 5 | 4 | No special comments |
| 8 | Male | 27 | Lawyer | College | 2 | 4 | 4 | 4 | No special comments |
| 9 | Female | 28 | Technician | College | 2 | 4 | 4 | 4 | No special comments |
| 10 | Male | 25 | Student | College | 3 | 4 | 5 | 4 | No special comments |

Wenjuanxing (www.wjx.cn), a widely used platform for conducting surveys in China, was used to develop the electronic questionnaire. An online poster with an access code or the website link to the questionnaire was distributed via two ways: (1) posted on our WeChat; and (2) distributed via WeChat groups, with an average of one to two RMB each as compensation. Each individual could only participate once on each WeChat account to avoid repeated submissions.

2.3. Statistical analysis

The data were analysed using SPSS™ for Windows, Version 16.0 (SPSS, Inc., Chicago, IL, USA). All data were categorical variables and shown as frequencies with percentages. For the convenience of analyses, each correct and incorrect response in mask-wearing behaviours were scored 1 and 0, respectively. For items 1, 2, 3, 4-1, 5-1, and 9, responses of “never” and “occasionally” were defined as incorrect, while “often” and “every time” were defined as correct. The opposite definitions were applied for items 4, 5, 6, 7, 11, and 13. Items 13-1, 14, and 15 were not calculated, leading to a total of 13 points (see Table 2 for details). The final score was labelled as “good” or “poor”, according to whether a score of 10 or more points (out of 13 points) was achieved, which was used as a dependent variable for the binary logistic regression analysis. Chi-squared tests were used to compare the “good” rates between groups and variables with $p < 0.05$ were included in the binary logistic regression analysis (Forward: LR). Finally, variables with $p < 0.05$ with their odds ratios (ORs) and 95% confidential intervals (CIs) were presented.

2.4. Ethics and informed consent

The study protocol was approved by the Affiliated Hospital of North Sichuan Medical College Ethics Committee (2020ER084-1). This study was an online survey, which was open to the public. As the identities of the participants were not ascertained, directly or through identifiers linked to the subjects, this study was considered in the category of exempt research. Although informed consent was not required, a brief introduction was provided to prospective research participants which indicated that participation is voluntary and anonymous, how long the questionnaire will take to complete, a brief description of what participants will be

doing, whom to contact with any questions, what feedback they will receive, and the data will be used as part of a research study.

3. Results

There were 10,290 people participating in the survey, among which 27 were from overseas and 98 people reported not wearing face mask during the past week and were excluded. Therefore, a total of 10,165 participants were included in the analysis, with a mask wearing compliance of 99%. The mean age of the participants was 30.1 ± 12.0 years (median 28, interquartile range 20–39), and their geographic distribution was categorised into seven major geographic areas in China (see Fig. 1). More details of the participants' demographic results are found in Table 2.

Concerning the evaluation of mask-wearing behaviours, as shown in Table 3, 41.8% of the participants seldom cleaned their hands before putting on a mask. Regarding the correct way to put on a mask, nearly all participants (96.5%) knew to make sure the mouth, nose, and chin were covered by the mask and 85.1% checked that there were no gaps between face and mask. However, only 20.2% and 8.0% never touched or adjusted the mask, respectively, while using it, with more than half (55.3%, 62.1%) of those who touched ($n=8108$) or adjusted ($n=9356$) their mask never or occasionally washed their hands afterward. A few people indicated that they often or always hung their masks under their chins (often 7.0%, always 9.4%) or uncovered their mouths or noses for a breath (often 2.9%, always 1.3%) while using it. Most of the people (94%) correctly removed the used masks, but fewer correctly disposed of their masks, with 7.6% of them discarding the masks into garbage bins without lids and 22.5% discarding them into garbage bin within their reach regardless of presence of a lid.

In terms of the types of face masks selected, disposable medical mask accounted for 93.8%, with 26.2% and 8.5% of respondents also reporting the use of N95 respirators and cloth face masks, respectively. Some participants reported wearing multiple masks simultaneously (occasionally 26.5%, often 2.1%, always 1.5%). More than half of the respondents ($n=5,981$, 58.8%) reported reusing disposable masks, with nearly two-thirds ($n=3,923$, 65.6%) of whom hanging the used mask in a well-ventilated place, and other treatments could be seen in Table 3. More than one-third (37.6%) of the respondents did not replace mask when it had been used for more than 8 hours. Social media platforms were the most common ways (76.4%) people had received instructions about face mask use.

Table 2
Demographic characteristics of the study participants and comparison of the frequencies of mask-wearing behaviours in different groups (N=10165).

| Category | Group | n% | Mask-Wearing behaviors | | |
|----------------------------------|--|-----------|--------------------------|----------|-------|
| | | | Good Rate/Poor Rate (n%) | χ^2 | p |
| Gender | Male | 3225/31.7 | 2233(69.2)/992(30.8) | 40.399 | 0.000 |
| | Female | 6940/68.3 | 5221(75.2)/1719(24.8) | | |
| Age | ≤14 | 407/4.0 | 369(90.7)/38(9.3) | 149.1 | 0.000 |
| | 15–34 | 6330/62.3 | 4406(69.6)/1924(30.4) | | |
| | 35–65 | 3394/33.4 | 2650(78.1)/744(21.9) | | |
| | >65 | 34/0.3 | 29(85.3)/5(14.7) | | |
| Areas | Northeast China | 341/3.4 | 264(77.4)/77(22.6) | 58.835 | 0.000 |
| | North China | 1535/15.1 | 1085(70.7)/450(29.3) | | |
| | East China | 2085/20.5 | 1446(69.4)/639(30.6) | | |
| | South China | 652/6.4 | 446(68.4)/206(31.6) | | |
| | Central China | 1680/16.5 | 1237(73.6)/443(26.4) | | |
| | Southwest China | 3447/33.9 | 2642(76.6)/805(23.4) | | |
| | Northwest China | 425/4.2 | 334(78.6)/91(21.4) | | |
| | City/Countryside | City | 5085(74.3)/1763(25.7) | | |
| | Countryside | 3317/32.6 | 2369(71.4)/948(28.6) | 9.185 | 0.002 |
| Education background | Middle school or below | 1406/13.8 | 1199(85.3)/207(14.7) | 221.7 | 0.000 |
| | High school | 3807/37.5 | 2917(76.6)/890(23.4) | | |
| | College | 3623/35.6 | 2484(68.6)/1139(31.4) | | |
| | Graduate degree | 1329/13.1 | 854(64.3)/475(35.7) | | |
| Current work/ living environment | Working in a relatively enclosed setting such as a hospital, airport, railway station, subway/metro station, bus, aircraft, train, grocery store, restaurant, or similar | 1225/12.1 | 929(75.8)/296(24.2) | 113.9 | 0.000 |
| | Working in multiple settings within a day; for example as a police officer, security guard, mail carrier, courier | 250/2.5 | 174(69.6)/76(30.4) | | |
| | Living in self-quarantine or with people in self-quarantine at home | 712/7.0 | 512(71.9)/200(28.1) | | |
| | Studying or taking part in activities in crowds | 360/3.5 | 239(66.4)/121(33.6) | | |
| | Studying or taking part in activities at home | 4421/43.5 | 3352(75.8)/1069(24.2) | | |
| | Indoor office environments | 1953/19.2 | 1276(65.3)/677(34.7) | | |
| | Outdoor open space | 1085/10.7 | 835(77.0)/250(23.0) | | |
| | Being sick and seeking diagnosis or treatments | 159/1.6 | 137(86.2)/22(13.8) | | |
| | Flu-like symptoms | Yes | 208(57.9)/151(42.1) | | |
| | | No | 7246(73.9)/2560(26.1) | | |
| | Living with people who were in self-quarantine | Yes | 192(74.1)/67(25.9) | | |
| | | No | 7062(73.3)/2644(26.7) | | |
| | Know about face mask use instruction | Yes | 7005(76.6)/2145(23.4) | | |
| | | No | 449(44.2)/566(55.8) | | |

Note: N, total sample; n, a subset of total sample.

Using a final score of 10 or more points defined as “good”, most (73.3%) of the participants demonstrated good compliance with face mask use. Finally, binary logistic regression analysis identified seven factors, specifically associated with good compliance; namely, gender, age, residence, educational background, current work/living environment, presence of flu-like symptoms, and experience with instructions regarding face mask use (Table 4). Males were less likely to exhibit higher compliance than females (OR=0.77, 95% CI = 0.70–0.85, $p=0.000$). Compared with the participants who were 14 years or less, those aged 15–34 and 35–65 years old showed lower compliance, with ORs of 0.42 (95% CI=0.29–0.62, $p=0.000$) and 0.59 (95% CI=0.41–0.87, $p=0.007$), respectively. People from North and South China showed lower compliance than those of people from Central China, with ORs of

0.81 (95% CI=0.68–0.96, $p=0.016$) and 0.77 (95% CI=0.62–0.95, $p=0.015$), respectively. Participants living in cities were more likely to report good compliance with face mask use than those living in the countryside (OR=1.30, 95% CI=1.17–1.46, $p=0.000$). Comparison of participants according to educational background showed a decreasing trend in compliance with mask-wearing behaviours in those with middle school or below education background compared with those in participants with high school diploma, college, or graduate degree (ORs= 0.73 [95% CI=0.61–0.89, $p=0.000$], 0.47 [95% CI=0.39–0.57, $p=0.000$], and 0.37 [95% CI=0.30–0.46], $p=0.000$, respectively). Participants who were sick and seeking diagnosis or treatments demonstrated 2.08-fold (95% CI=1.26–3.41, $p=0.004$) higher compliance than those of participants in outdoor open spaces, whereas lower compliance were shown in those

Table 3

The characteristics of the public mask-wearing behaviours (N=10165).

| Items | Choices | Results(n/%) |
|---|---|--------------|
| 1. Before putting on a mask, did you clean your hands with alcohol-based hand rub or soap and water? | never | 943/9.3 |
| | occasionally | 3307/32.5 |
| | often | 2652/26.1 |
| | always | 3263/32.1 |
| 2. After putting on a mask, did you make sure that your mouth, nose, and chin were covered by the mask? | never | 56/0.6 |
| | occasionally | 292/2.9 |
| | often | 1356/13.3 |
| | always | 8461/83.2 |
| 3. After putting on a mask, did you make sure that there were no gaps between your face and the mask? | never | 345/3.4 |
| | occasionally | 1171/11.5 |
| | often | 2219/21.8 |
| | always | 6430/63.3 |
| 4. Did you touch the mask while using it? | never | 2057/20.2 |
| | occasionally | 6463/63.6 |
| | often | 1125/11.1 |
| | always | 520/5.1 |
| 4-1. (If Q4 not answering never). If you did touch the mask, did you clean your hands with alcohol-based hand rub or soap and water immediately?(N=8108) | never | 999/12.3 |
| | occasionally | 3482/43.0 |
| | often | 2028/25.0 |
| | always | 1599/19.7 |
| 5. Did you adjust the mask while using it? | never | 809/8.0 |
| | occasionally | 5561/54.7 |
| | often | 2233/22.0 |
| | always | 1562/15.3 |
| 5-1. (If Q5 not answering never). If you did adjust the mask, did you clean your hands with alcohol-based hand rub or soap and water immediately?(N=9356) | never | 1763/18.9 |
| | occasionally | 4044/43.2 |
| | often | 1705/18.2 |
| | always | 1844/19.7 |
| 6. Did you hang the mask under the chin while using it? | never | 4311/42.4 |
| | occasionally | 4188/41.2 |
| | often | 716/7.0 |
| | always | 950/9.4 |
| 7. Did you uncover your mouth or/and nose for a breath while using the mask? | never | 5824/57.3 |
| | occasionally | 3920/38.5 |
| | often | 290/2.9 |
| | always | 131/1.3 |
| 8. How did you remove the used mask? (Multiple choices) | Remove it by taking off the laces of the mask | 9560/94.0 |
| | Remove it by touching the front of the mask | 425/4.2 |
| | Remove it by touching the inside of the mask | 180/1.8 |
| | never | 509/5.0 |
| 9. When you removed the mask, did you clean hands with alcohol-based hand rub or soap and water immediately? | occasionally | 2445/24.1 |
| | often | 2485/24.4 |
| | always | 4726/46.5 |
| 10. After you removed the mask, how did you dispose of it? (Multiple choices) | Discard it into a garbage bin with a lid | 3474/34.2 |
| | Discard it into a garbage bin without a lid | 775/7.6 |
| | Discard it into a garbage bin for the used mask | 5725/56.3 |
| | Discard it into a garbage bin in your reach whatever it has a lid or not | 2289/22.5 |
| 11. Did you wear multiple masks at the same time? | never | 7104/69.9 |
| | occasionally | 2694/26.5 |
| | often | 216/2.1 |
| | always | 151/1.5 |
| 12. When did you replace the mask with a new one? (Multiple choices) | Replace it as soon as it is damp | 3778/37.2 |
| | Replace it when it has been used for no more than 4 hours | 2141/21.1 |
| | Replace it when it has been used for a period between 4 hours and 8 hours | 4445/43.7 |
| | Replace it when it has been used for more than 8 hours | 3822/37.6 |

(Continued on next page)

Table 3 (Continued).

| Items | Choices | Results(n/%) |
|--|---|--|
| 13. Did you reuse disposable masks? | never occasionally often always | 4184/41.2 4322/42.5 1400/13.8 259/2.5 |
| 13-1. (If Q13 not answering never). If you did reuse the disposable masks, how did you disinfect the disposable mask? (Multiple choices)(N=5981) | Hang it at the well-ventilated place Heat it by electric hair drier Steam it Boil it Heat it by oven Sterilize it with alcohol Insert a gauze inside the disposable mask when wearing it, and discard it after it was removed Wear a cloth mask inside the disposable mask Other ways No special treatment | 3923/65.6 668/11.2 210/3.5 332/5.6 60/1.0 1211/20.3 698/11.7 315/5.3 721/12.1 1019/17.0 |
| 14. Which type of face masks did you choose? (Select all that apply.) | Cloth face mask Disposable medical mask N95 respirators | 859/8.5 9533/93.8 2666/26.2 |
| 15. How did you get to know about using face masks? (Multiple choices) | Informed by family members or friends TV News Social media platforms Community dissemination Others | 3400/37.2 6262/68.4 6992/76.4 3424/37.4 2170/23.7 |

Note: N, total sample; n, a subset of total sample.

studying or taking part in activities in crowds and those who were working in indoor offices, with ORs of 0.69 (95% CI=0.53–0.92, $p=0.010$) and 0.67 (95% CI=0.55–0.80, $p=0.000$), respectively. In addition, participants with coughs or sneezing symptoms reported lower compliance than those without these symptoms (OR=0.53, 95% CI=0.42–0.66, $p=0.000$), while the participants who knew about face mask use instructions exhibited significantly higher compliance with mask-wearing behaviours (OR=4.13, 95% CI=3.60–4.75, $p=0.000$).

4. Discussion

The major findings of this study were that nearly all people wore masks in the context of COVID-19, and most participants demonstrated good compliance in terms of mask-wearing behaviours in general; however, hand hygiene before and during mask use, the rationale for choice of mask, reusing disposal face masks, and the disposal of disposable masks required improvement. Furthermore, whether or not participants had received instructions on face mask use was the strongest predictor of good mask-wearing behaviours, irrespective of their educational backgrounds. Other factors associated with good compliance included



Fig. 1. Distribution of the study participants.

Table 4

Binary logistic regression analysis on the influencing factors of mask wearing behaviours.

| Variables | β | S.E. | Wald | <i>p</i> | OR | OR95%CI |
|---|---------|------|--------|----------|------|-----------|
| Gender | | | | | 1.00 | |
| Female | | | | | 0.77 | 0.70–0.85 |
| Male | −0.26 | 0.05 | 25.54 | 0.000 | | |
| Age | | | | | 1.00 | |
| ≤14 | | | | | 0.42 | 0.29–0.62 |
| 15–34 | −0.86 | 0.19 | 19.81 | 0.000 | | |
| 35–65 | −0.52 | 0.19 | 7.32 | 0.007 | 0.59 | 0.41–0.87 |
| Areas | | | | | 1.00 | |
| Central China | | | | | 0.81 | 0.68–0.96 |
| North China | −0.21 | 0.15 | 2.41 | 0.016 | | |
| South China | −0.26 | 0.11 | 5.93 | 0.015 | 0.77 | 0.62–0.95 |
| City/Countryside | | | | | 1.00 | |
| Countryside | | | | | 1.30 | 1.17–1.46 |
| City | 0.27 | 0.06 | 21.74 | 0.000 | | |
| Education background | | | | | 1.00 | |
| Middle school or below | | | | | 0.73 | 0.61–0.89 |
| High school | −0.31 | 0.10 | 10.41 | 0.001 | | |
| College | −0.75 | 0.10 | 59.08 | 0.000 | 0.47 | 0.39–0.57 |
| Graduate degree | −1.00 | 0.11 | 84.48 | 0.000 | 0.37 | 0.30–0.46 |
| Current work/ living environment | | | | | 1.00 | |
| Outdoor open space | | | | | 0.69 | 0.53–0.92 |
| Studying or taking part in activities in crowds | −0.36 | 0.14 | 6.66 | 0.010 | | |
| Indoor office environments | −0.41 | 0.09 | 18.65 | 0.000 | 0.67 | 0.55–0.80 |
| Being sick and seeking diagnosis or treatments | 0.73 | 0.25 | 8.27 | 0.004 | 2.08 | 1.26–3.41 |
| Flu-like symptoms | | | | | 1.00 | |
| No | | | | | 0.53 | 0.42–0.66 |
| Yes | −0.64 | 0.12 | 31.14 | 0.000 | | |
| Know about face mask use instruction | | | | | 1.00 | |
| No | | | | | 4.13 | 3.60–4.75 |
| Yes | 1.42 | 0.07 | 400.10 | 0.000 | | |
| Constant | 1.11 | 0.21 | 27.81 | 0.000 | 3.04 | |

Notes: S.E.—standard error, OR—odds ratio, 95% CI—95% confidence interval.

specific situations, location, and gender. The influence of age needs further investigation.

Handwashing is one of the most overlooked actions, with concerns owing to a false sense of security related to the wearing of face masks. In our study, nearly half of the participants seldom cleaned their hands before donning a mask, whereas more than two-thirds of them appropriately used proper hand cleaning when they doffed the mask. Of note, most participants touched or adjusted their masks while wearing them, more than half of whom did not wash their hands afterward. Thus, it seemed that the concerns may be true. However, a systematic review reported that hand hygiene was poorly practiced globally even after contact with excreta, with prevalence varying between 5% and 25% in low- and middle-income countries and 48% to 72% in high-income countries (Freeman et al., 2014). With increased risk perceptions, such as during the height of the severe acute respiratory syndrome epidemic from March to April 2003 in Hong Kong, 65.3% washed their hands after relevant contact (Leung et al., 2003). An obvious increase in hand hygiene was also observed during the 2009 influenza A (H1N1) pandemic in Thailand due to the extensive national hand hygiene educational campaigns (Simmerman et al., 2011). Therefore, it is important to increase the public's risk perception and to strengthen efforts to disseminate relevant guidance. Our study revealed that participants were aware of the need for hand hygiene after removing a mask; however, such measures need to be emphasized before wearing masks and for the time during which individuals are wearing masks. It is recommended to have a sanitiser or some disinfectant wipes on hand in order to address the inconvenience of frequent hand hygiene.

Reasonable selection of different types of face masks is another problem for the public. As shown in Table 3, more than one-quarter of participants wore N95 respirators, which are not recommended for the general population, and 30.1% of the participants described wearing multiple masks simultaneously. The pub-

lic may not know that the reliability of N95 respirators to prevent the spread of such airborne infectious diseases depends on their fit to the wearer and that fit testing is required before the use of N95 respirators to ensure the best fit possible (CDC, 2020), and N95 respirators are not more effective in preventing laboratory-confirmed influenza than disposable medical masks (Long et al., 2020). Moreover, more adverse effects and discomfort were associated with N95 respirators and multiple masks (Macintyre et al., 2013; Kao et al., 2004). Therefore, the public should be aware of the related issues to avoid a blind choice of mask types. It was plausible for the public to use cloth masks as alternatives when the medical masks were in shortage, which was also recommended by the Center for Disease Control and Prevention (CDC) for the general population in public settings since April (CDC, 2020). It is noted that before disposable masks were available, cloth masks were widely used by health providers during operations (Leung et al., 2020).

Reusing face masks is an inevitable issue when facing a mask availability crisis. Under the severe situation of mask shortage, the general population were recommended to reuse disposable masks if they are clean, but should be replaced with new masks if dirty or used for more than 8 hours (National Health Commission of the People's Republic of China, March 18, 2020). In our survey, more than half of the respondents reused disposable masks, but more than one third of them did not replace with a new one even it has been used for more than 8 hours. Most people hung the used mask in well-ventilated places for the next time. Other ways, such as using alcohol, steaming, boiling, and inserting a gauze or wearing a cloth mask inside the disposable mask, were also adopted by some members of the public. Of note, no evidence supports the disinfection of disposable masks. As cloth mask can be easily washed with soap and water or laundry detergent to prevent contamination (Desai et al., 2020), it should be recommended as the preferred option for the general population in the face of mask shortage (CDC, 2020).

Another concern is the disposal of used masks. WHO required that people discard used masks immediately in a closed bin (WHO, 2020b). Our survey revealed that 7.6% of the respondents discarded their masks into a garbage bin without a lid and 22.5% threw them into whatever garbage bins were available regardless of whether they had lids. This may be because the Chinese National Health Commission only emphasized that confirmed and suspected cases must dispose of used masks as medical waste, while healthy people should follow the disposal rules for household waste (National Health Commission of the People's Republic of China, Jan. 31, 2020). Many communities and public areas were given trash bins for the used masks, and more than half of the respondents reported disposing of the masks this way. However, discarded face masks were reportedly found in many places, such as buses, train stations, streets, etc (Wang et al., 2020). As we considered that respondents were less likely to report discarding masks anywhere, we did not ask them about this behaviour. Therefore, specific measures to address mask disposal should be actively promoted and more trash bins for used masks with attractive logo should be placed in public areas.

Among the factors influencing mask-wearing behaviours, we found that people who exposed to instructions regarding how to use face masks demonstrated approximately four-fold better compliance than those who did not. Intriguingly, the higher the educational background, the worse the compliance. Thus, good mask-wearing habits appeared to depend on how much education about mask use had been received rather than on education levels. This finding also supported the hypothesis proposed by Greenhalgh and colleagues (2020) that, in the context of COVID-19, people can be taught to use masks properly and will do so consistently without abandoning other important anti-contagion measures. This evidence, combined with our results regarding the approaches that the participants took to obtaining related information, suggests that institutions and scholars should spare no efforts to disseminate guidance via various methods, among which social media may most benefit the public.

We also observed that different situations influenced people's behaviours. People who were sick and who went to hospitals or clinics displayed much better compliance. This may be attributed to concerns about the high risks of COVID-19 transmission in these settings and the association between higher risk perception with good compliance with facemask use (MacIntyre et al., 2015; Rubin et al., 2009). Similarly, people living in the city showed better compliance than those among people in the countryside. Moreover, people from North and South China showed lower compliance than those in people from Central China, where people may perceive higher risks of infection rate. However, when people exhibited flu-like symptoms, such as cough and sneezing, they may feel discomfort and touch their facemasks frequently, leading to worsening compliance. In addition, people working in relatively enclosed or multiple settings and living in self-quarantine or with people in self-quarantine did not show higher compliance than those in people in outdoor open space. Participants showed lower compliance when studying or participating in events in crowds. Therefore, more education about frequent hand hygiene and facemask replacing when showing flu-like symptoms, as well as clear warnings and about the potential risks in different situations should be conveyed to the public.

Gender is another factor affecting mask-wearing behaviours. Consistent with previous studies investigating changes in public behaviours during influenza outbreaks (Rubin et al., 2009; Park et al., 2010), female participants in our survey exhibited better compliance with face mask use than the male participants. Nonetheless, the effect of age exhibited different patterns, with those aged 14 or below years old demonstrating the best compliance and other groups displaying increasing trends of better

compliance with increasing age. This may be because 87.2% of the youngest group in our study was 12–14 years of age and had returned to school when we collected the data and were asked to wear masks under strict supervision by their teachers. This also suggests that strict management and education may improve public behaviours. However, the sample sizes of the youngest ($n=407$) and oldest groups ($n=34$) were relatively smaller than those in the age group of 15–34 ($n=6330$) and 35–65 ($n=3394$), thus the effect of age needs further investigation.

4.1. Strengths and limitations

To our knowledge, this is the first study to investigate mask-wearing behaviours by the general public in the context of pandemics. The results provide evidence on how the public used face masks and what factors influenced their behaviours, which are of importance to China and other countries. Although a previous survey explored a related issue, it included only primary school students from Wuhan (Chen et al., 2020). Our study included diverse participants, who were not health care providers. We disseminated the best evidence regarding mask-wearing and educated participants while performing the survey, which may benefit the public.

However, this study has some limitations. First, this study used social media as the main method to disseminate the survey. Participants without access to the internet were probably not included. Second, the distribution of the study participants was imbalanced across regions ($n=341$ – 3447); therefore, the subgroups of variables might not be representative of the population. Third, this study could not determine how many participants reviewed the online poster or survey but decided not to complete the survey; thus, the presence of non-response bias could not be assessed. Finally, as the behaviours were self-reported, reporting bias was possible. Overall, generalisation of the results should be regarded with caution.

4.2. Conclusions and implications

Due to the highly contagious characteristics of COVID-19 and the continued severe situation globally, mask-wearing has become a part of our ordinary lives. Understanding how the public use face masks and what factors are associated with good compliance will be useful in identifying ways to promote correct mask-wearing behaviours.

Our results revealed that, in the context of the COVID-19 pandemic in China, nearly all people wore face mask and most of them used it properly; however, there remain some aspects that require further promotion. Hand hygiene before and during mask-wearing should be particularly emphasized in future evidence dissemination or behaviour-change interventions; moreover, choosing appropriate types of face masks, reusing disposal face masks, and disposing of used face masks also cannot be neglected. Taking measures to inform as many people as possible plays a critical role in promoting public mask-wearing behaviours. When disseminating evidence, therefore, different influencing factors should be considered to cover different populations. A variety of approaches should be adopted to deliver government warnings and alerts explicitly and ubiquitously. Social media is the most powerful approach to reach audiences and facilitate data collection; however, further studies on how social media could promote behaviour change in public are warranted.

Funding

This study was supported by a grant from the National Natural Science Foundation of China (72042007) and a grant from the Bureau of Science and Technology, Nanchong, China (20YFZJ0102).

Data Sharing Statement

Full top-line results for the survey are available from JLH at jhu4@vcu.edu.

Conflict of interest

The authors declare there was no conflict of interest.

CRediT authorship contribution statement

Min Tan: Conceptualization, Methodology, Investigation, Project administration, Formal analysis, Writing - original draft, Writing - review & editing. **Yingying Wang:** Conceptualization, Methodology, Investigation, Formal analysis, Writing - review & editing. **Li Luo:** Conceptualization, Methodology, Project administration, Funding acquisition, Writing - review & editing. **Jiale Hu:** Conceptualization, Methodology, Project administration, Formal analysis, Writing - review & editing.

Acknowledgments

Thanks are due to all the participants for their efforts and time, the anonymous reviewers for their constructive suggestions, and Dr. Pammla Petrucka from the College of Nursing, University of Saskatchewan of Canada for her great editing effort in the final version of the manuscript.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.ijnurstu.2020.103853](https://doi.org/10.1016/j.ijnurstu.2020.103853).

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